

CONTRACT REQUIREMENTS	CONTRACT ITEM	MODEL	CONTRACT NO.
Exhibit E, Para. 3.13	Work Package No. 712	LM-7	NAS 9-1100

Type II Document

LM-7 BPA TEST & CHECKOUT
REQUIREMENTS DOCUMENT
REPORT NO. LPL 561-7

21 AUGUST 1968

PREPARED BY: P. F. Brus
S/CAT TEST ENGINEERING

CHECKED BY M. C. Brady

APPROVED BY: Paul Butler
PAUL BUTLER
ASSISTANT PROGRAM MANAGER - S/CAT

T. J. Kelly
T. J. KELLY
ASSISTANT PROGRAM MANAGER - TECHNICAL

G. Gibbons
G. GIBBONS
LM-7 SPACECRAFT DIRECTOR

TABLE OF CONTENTS

	Page
1.0 <u>Introduction</u>	1-1
1.0 Scope and Precedence	1-1
1.1 Scope	1-1
1.2 Abstract	1-1
1.3 Requirements Matrix	1-1
1.4 FEAT, System Verification, Plugs-In	1-1
1.5 FEAT, Mission Oriented, Plugs-Out	1-1
1.6 Retest Philosophy	1-2
1.7 General Requirements	1-2
1.8 Safety Requirements	1-2
1.9 Subsystems Support Matrix	1-2
2.0 <u>Test Objectives</u>	2-1
2.1 Structural Mechanical Subsystem	2-1
2.2 Electrical Power Subsystem	2-5
2.3 Environmental Control Subsystem	2-12
2.4 Guidance and Navigation Subsystem	2-26
2.5 Rendezvous Radar	2-32
2.6 Landing Radar	2-39
2.7 Stabilization and Control	2-41
2.8 Reaction Control	2-52
2.9 Propulsion Subsystem	2-57
2.10 Explosive Devices Subsystem	2-69
2.11 Communications Subsystem	2-73
2.12 Instrumentation Subsystem	2-78
2.13 Crew Provisions Subsystem	2-81
3.0 <u>FEAT, System Verification, Plugs-In</u>	3-1
4.0 <u>FEAT, Mission Oriented, Plugs-Out</u>	4-1
5.0 <u>Retest Philosophy</u>	5-1
A. General	5-1
B. Electrical	5-1
C. Fluid and Mechanical	5-1
6.0 <u>General Requirements</u>	6-1
7.0 <u>Safety Requirements</u>	7-1
8.0 <u>Subsystem Support Matrix</u>	8-1

SECTION 1.0 - INTRODUCTION

Section 1.0 ~ Introduction

- 1.0 Scope and Precedence.
- 1.1 Scope.

This Test and Checkout Requirements Document lists LM-7 Vehicle functions to be tested at the Grumman Bethpage facility from build-up to delivery to Cape Kennedy.

Precedence.

Reference (a); LSP 470-2, LM Master End Item Specification, Part II, Product Configuration and Acceptance Test Requirements.

Reference (b); LSP 470-9, LM-7 Contract End Item Detail Specification - Product Configuration and Acceptance Test Requirements, Part II.

Reference (c); SN8-R014 LM-4 and subsequent Test and Checkout Requirements Document (TCRD) for KSC.

References (a) and (b) shall govern for inconsistencies, if any, between the contract specification test requirements and those listed herein.

Reference (c) shall govern for inconsistencies, if any, between this document and the KSC TCRD.

- 1.2 Abstract.

The Test and Checkout Document is provided in accordance with the requirements of Apollo Directive 26. Changes to this document are to be made with replacement pages having an index to indicate change record. All changes to the document require the approval of Resident Apollo Spacecraft Program Office or his designated representative. This document contains separate sections as follows:

- 1.3 Requirements Matrix (Section 2.0)

This section lists the test requirements by subsystem, and identifies in which Test Location requirements are satisfied. KSC Requirements is included as a general classification.

- 1.4 FEAT, System Verification, Plugs-In (Section 3.0)

This section contains, in narrative form, a description of the plugs-in System Verification Test.

- 1.5 FEAT, Mission Oriented, Plugs-Out (Section 4.0)

This section contains, in narrative form, a description of the plugs-out mission simulation test.

1.6 **Retest Philosophy (Section 5.0)**

This section contains the general ground rules to be followed for spacecraft or hardware verification in the event of test invalidation due to S/C equipment removal, cable disconnections, repair, etc.

1.7 **General Requirements (Section 6.0)**

General test requirements for vehicle testing are contained in this section.

1.8 **Safety Requirements (Section 7.0)**

Safety requirements for testing are contained in this section.

1.9 **Subsystem Support Matrix (Section 8.0)**

This section provides a matrix of systems required in support of vehicle subsystem testing.

SECTION 2.0 - TEST OBJECTIVES

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC	
			A/S	D/S	A/S	D/S		
	BPA						NON-FEAT	FEAT
2.1 STRUCTURAL MECHANICAL SUBSYSTEM.								
2.1.1 Landing Gear Installation & Functional Test.							X	
	a.	Verify installation of the four Landing Gear Assemblies on the LM vehicle.				X		
	b.	Verify the overall functional capability of the Landing Gear System with regard to the deployment & downlock mechanism.				X		
	c.	Verify the time for deployment, from the up & locked to the full down and locked position as an indication of proper operation of components exercised during deployment and downlock.				X		
	d.	Verify position of release of Lunar Surface Sensing Probe Uplock Mechanism.				X		
	e.	Verify Landing Gear "Down and Locker" switch operation.				X		

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	
					NON-FEAT	FEAT
f. Verify probe "Surface Contact" switch operation.			X		X	
g. Verify that the Landing Gear probes have been retracted and that the Luna. Surface Sensing Switches were reset.					X	
h. Verify that Landing Gear are retracted and that the Flight Up-locks have been installed and preloaded.					X	
2.1.2 Crew Compartment Fit & Functional Test.					X	
	a.	To verify that crew equipment items are compatible with LM vehicle stowage provisions.			X	
	b.	To verify that crew equipment items are functionally capable of being used within the LM cabin.			X	

TEST OBJECTIVES	COLD FLOW						FINAL ASSEMBLY						KSC BPA	
	A/S		D/S		A/S		D/S		MATED		NON-FEAT			
	A/S	D/S	A/S	D/S	A/S	D/S	MATED	NON-FEAT	FEAT	NON-FEAT	FEAT	NON-FEAT		
c. To verify that stowage provisions for crew equipment items are generally compatible with the LM mission sequence.							X			X				
d. To verify that crew equipment items are functionally capable of being used as a package.							X			X				
2.1.3 D/S - Weight & Center of Gravity Check,							X			X				
a. To determine the dry weight of the Descent Stage.														
b. To determine the horizontal (X-Z) center of gravity of the Descent Stage.														
2.1.4 A/S - Weight & Center of Gravity Test,														
a. To determine the dry weight of the L/L Ascent Stage.														
b. To determine the horizontal (X-Z) center of gravity of the LM Ascent Stage.														

TEST OBJECTIVES	PLANNED		BPA		KSC				
	C/LD FLOW	FINAL ASSEMBLY	A/S	D/S	A/S	D/S	MATED	NON-FEAT	FEAT
2.1.5 Docking Test - LM A/S to C/M.							X		
	a.	Verify pneumatic seal between LM docking ring surface and CM docking ring seal. (For BPA LM A/S only)					X		
	b.	Verify mechanical mating of LM/CM umbilical connectors.					X		
	c.	Verify Crew Optical Alignment Sight and Docking Target alignment.					X		
	d.	Verify that A/S can be pressurized from the CM.					X		
2.1.6 LM to SLA Mate.									
	a.	Perform a LM/SLA optical azimuth transfer.					X		
2.1.7 Thermal Emissivity & Solar Absorptance Test.									
	a.	Verify that the thermal emissivities of LM panels,							

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	FEAT
thermal insulating blankets, and critical vehicle surfaces are within tolerance.			X	X			X
b. Verify that the solar absorptance values of LM panels, thermal insulating blankets, and critical vehicle surfaces are within tolerance.			X	X			X
2.2 ELECTRICAL POWER SUBSYSTEM.							
2.2.1 Ascent Stage EPS Power Distribution Verification.					X	X	X
c. Verify continuity between Commander's DC bus and LM Mission Pilot's DC buses.					X	X	X

TEST OBJECTIVES	PLANNED	BPA	FINAL ASSEMBLY				KSC
			A/S	D/S	A/S	D/S	
d. Verify single point grounding to vehicle structure of each negative bus.					X		
e. Verify isolation between positive & negative buses with load circuit breakers open.					X		
f. Verify isolation between positive and negative buses with all load circuit breakers closed (no loads connected).					X		
g. Verify voltage of correct polarity at proper connector pins (or at most feasible point closest to load) using current limited voltage, and closing circuit breakers one at a time.					X		
h. Measure resistance of AC feeder between each inverter output interface connector and AC bus.					X		
i. Verify isolation of translunar buses from LM vehicle ground system (no translunar loads connected).					X		

TEST OBJECTIVES		COLD FLOW		FINAL ASSEMBLY				BPA	KSC
		A/S	D/S	A/S	D/S	MATED	NON-MATED	FEAT	
2.2.2	Descent Stage Power Distribution Verification.					X			

a. Verify continuity of main DC feeders from ECA's up to DC buses.
 b. Verify isolation between Commander's DC bus and LM Mission Pilot's DC bus.
 c. Verify continuity between Commander's DC bus and LM Mission Pilot's DC bus with crosstie circuit breakers closed.
 d. Verify isolation between positive and negative buses with load circuit breakers open.
 e. Verify isolation between positive and negative buses with all D/S load circuit breakers closed (no loads connected).
 f. Verify isolation of ED control circuitry.

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		BPA	KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT		
g. Verify voltage of correct polarity at proper connector pins (or at most feasible point closest to load) using bus voltage and closing circuit breakers one at a time.					X			
h. Verify voltage of correct polarity at proper connector pins while operating cabin EPS and ED switches.					X			
i. Verify voltage at Scientific Equipment interface connector (Lunar Landing Vehicle only).					X			
2.2.3 EPS Functional Checkout and Malfunction Detection.							X	X
	a. Monitor bus voltage.						X	X
	b. Verify EPS readout on ACE and on LM cabin indicators.						X	X
	c. Monitor no-load voltage and frequency of AC inverter or 400 Hz Isolation Transformer.						X	X
	d. Verify reverse current readout capability.						X	X

TEST OBJECTIVES	PLANNER		BPA		KSC		
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	FEAT
e. Verify overcurrent readout capability.					X		X
f. Verify manual switchover capability.					X	X	X
g. Check for any malfunctions during normal operation under load.					X		X
h. Verify Automatic Power switchover using the abort stage switch.					X	X	X
i. Reset of malfunction indication.					X	X	X
j. Verify descent battery deadface switch.					X	X	X
k. Verify hi/low voltage tap switches					X	X	X
2.2.4 Lighting Functional Test.							
a. Verify display numerics operation, dimmer control response, and dimmer override (using GSE Lighting Test Set).					X	X	X
b. Verify display numerics operation, dimmer control response, and dimmer override (using Lighting Control Assembly).					X	X	X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
c. Verify docking light operation.				X	X	
d. Verify tracking light operation.				X	X	
e. Verify portable utility light operation.				X	X	
f. Verify power failure indicator lights.			X		X	
g. Verify integral and flood lighting operation. (Abbreviated for Lios.)			X	X	X	
h. Verify C&W annunciator and component caution light operation.			X	X	X	
i. Verify master alarm operation.			X	X	X	
j. Verify voltage at COAS and sequence camera interfaces.			X		X	
2.2.5 LM/CM Interface Checkout.						
a. Verify ED subsystem turn-on.				X	X	
b. Verify electrical continuity.				X	X	
c. Verify electrical isolation.				X	X	
d. Verify ED subsystem turn-off.				X	X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC	
	A/S	D/S	A/S	D/S	MATED			
					NON-FEAT	FEAT		
e. Verify CSM Interface Unit turn-on.					X		X	
f. Verify activation of EPS buses with CSM Interface Stimuli Unit.					X		X	
g. Verify activation of EPS logic for internal power operation.					X		X	
h. Verify CSM Interface Unit turn-off.					X		X	
2.2.6 LM/CM Umbilical EPS Functional Checkout.								
a. Verify activation of CSM subsystems.						X	X	
b. Verify LM/SLA separation functionally.						X	X	
c. Verify activation of LM EPS buses with CM Stimuli.						X	X	
d. Verify activation of LM EPS logic for battery power operation.						X	X	
2.2.7 LM/SLA/LUT Umbilical EPS Functional Checkout.							X	
a. Verify LUT power transfer interface for relay junction box LUT power contactor operation.								

TEST OBJECTIVES	PLANNED		BPA				KSC	
	COLD FLOW		FINAL ASSEMBLY					
	A/S	D/S	A/S	D/S	MATED	NON-FEAT		
b. Verify activation of EPS buses with GSE power.				X			X	
c. Verify activation of EPS logic for internal power operation.							X	
d. Emergency shutdown capability verification.							X	
2.2.8 EPS Flight Battery Activation.								
a. Perform activation procedure.							X	
b. Perform loading tests.							X	
2.3 ENVIRONMENTAL CONTROL SUBSYSTEM.								
2.3.1 Heat Transport Section (HTS).								
2.3.1.1 To Verify Structural Integrity.				X	X		X	
a. Proof pressure test A/S primary loop D/S primary loop and secondary loop.								
b. Proof pressure test interstage QDs in mated configuration.								
2.3.1.2 To Verify External Leakage.								
a. Leak check A/S primary loop, D/S primary loop and secondary loop using He probe method.				X	X			

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY		MATED	NON-MATED	FEAT	KSC
	A/S	D/S	A/S	D/S				
b. Leak check A/S and D/S primary loop using GN ₂ pressure decay method.			X	X		X		
c. Leak check A/S interstage QD's.								
d. Leak check mated interstage QD's.								
2.3.1.3 To Verify Internal Leakage					X			
a. Verify inter-coolant loop leakage using GH _e probe method.								
2.3.1.4 To Service HTS.					X			
a. Flush primary and secondary loops with water.						X		
b. Flush loops excluding W/G accumulator, with isopropyl alcohol, purge and evacuate to dry.						X	X	
c. Evacuate and fill mated HTS primary loop, and secondary loop with W/G.						X	X	
d. Flush W/G accumulator with water.						X	X	
e. Check for gas entrapment in primary and secondary loops.						X		X

TEST OBJECTIVES	PLANNED		BPA		KSC
	COLD FLOW		FINAL ASSEMBLY		
	A/S	D/S	A/S	D/S	MATED
1. Fill mated Interstage QD's.					X
2. 3.1.5 Functionally Check HPS.					
a. Establish system head curves for primary and secondary loops.				X	
b. Turn on and verify primary loop pumps operation.				X	
c. Turn on and verify primary loop pump flow rate.				X	X
d. Turn on and verify secondary loop pump.				X	X
e. Turn on and verify secondary pump flow rate.				X	X
f. Verify water glycol accumulator low level C&W.				X	X
g. Verify primary glycol ΔP low level C&W.				X	X
h. Verify primary glycol high temperature C&W.				X	X

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC	
			A/S	D/S	A/S	D/S		
							NON-FEAT	FEAT
1. Verify coolant regenerative heat exchanger & cabin temperature control valve operation.						X		X
j. Verify HTS Operational Flight Instrumentation.						X		X
k. Verify primary loop operation at altitude under total heat loads with cooling provided by water boiler.						X		X
2.3.2. Water Management Section (WMS)								
2.3.2.1. To Verify Structural Integrity.						X		
a. Proof pressure test A/S high and low pressure network.								
b. Proof pressure test D/S high pressure network.								
2.3.2.2. To Verify External Leakage.								
a. Leak check A/S and D/S high and low pressure networks using GH _e probe method.						X		X

TEST OBJECTIVES	PLANNED		BPA		KSC		
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATEJ	NON-FEAT	FEAT
b. Leak check A/S high & low pressure network using GN ₂ pressure decay method.				X		X	
c. Leak check D/S WMS using GN ₂ pressure decay method.				X		X	
d. Leak check mated WMS high & low press. Networks up to shut off valves using GN ₂ pressure decay method.				X		X	
2.3.2.3. Verify Internal Leakage of WMS.							
a. Leak check A/S and D/S tank bladders from water to gas and gas to water side using GN ₂ volumeter displacement method.				X		X	
b. Leak check A/S water tank check valves using GN ₂ volumeter displacement method.				X		X	
c. Check leakage to reference pressure side (suit circuit ass'y) of water pressure regulators using fluid displacement method.				X		X	
d. Leak check water separator check valves using fluid displacement method.				X		X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
			A/S	D/S	A/S	D/S	
e.	Leak check water tank select valve in ASC and DES positions using fluid displacement method.				✓		
f.	Leak check ASC H ₂ O, DES H ₂ O, primary evaporator flow, and secondary evaporator flow valves using fluid displacement method.				X		
2.3.2.4. Servicing of WMS.							
a.	Evacuate and flush with water to meet cleanliness requirements.				X		
b.	Evacuate and flush with bactericide to meet sterilization requirements.				X		
c.	Evacuate and flush with ethyl alcohol to meet sterilization requirements.				X	X	
d.	Flush and fill with water.				X		
e.	Purge and evacuate to dry.				X	X	
2.3.2.5. Calibration of WQMD.							
a.	Perform calibration using GN ₂ .				X		
b.	Perform calibration verification using H ₂ O.				X		

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY				KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
2.3.2.6. Functionally Test the WMS using GN ₂ .					X	X	X
a. Verify D/S tank low level C&W.					X	X	X
b. Verify A/S tanks low level and differential C&W.					X	X	X
c. Conduct gaseous flow tests to verify continuity of WMS paths and water regulator functions in Cabin and Egress modes.					X	X	X
d. Verify WMS Operational Flight Instrumentation.					X	X	X
2.3.2.7. Functionally Test the WMS using Water.					X	X	X
a. Verify D/S tank low level C&W.					X	X	X
b. Verify A/S tanks low level C&W.					X	X	X
c. Verify primary & secondary W/B operation.					X	X	X
d. Verify primary & secondary water reg's function in cabin mode & egress mode.					X	X	X

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY		KSC			
	A/S	D/S	A/S	D/S		MATED	NON-FEAT	FEAT
e. Verify primary & secondary water recg's function in simulated cabin & egress mode.					X			
f. Verify WMS Operational Flight Instrumentation.					X			X
g. Dryout & restart of primary W/B							X	X
h. Verify water supply through water dispenser.					X			X
i. Recharge PLSS with water.							X	X
j. Collect condensate from PLSS							X	X
2.3.3. Oxygen Cabin Pressure Section (OCPS).								
2.3.3.1. To Verify Structural Integrity.					X			
a. Proof pressure test A/S OCPS.								
b. Proof pressure test D/S OCPS.					X			
c. Proof pressure test mated interstage QD.							X	

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
2.3.3.2. Verify External Leakage of OCPS.						
a. Leak check A/S OCPS using GH _e probe.	X					
b. Leak check D/S OCPS using H _e probe method.		X				
c. Leak check mated interstage QD at operating pressure using GH _e probe method.			X		X	
d. Leak check A/S OCPS using GOX make up method.		X			X	
e. Leak check A/S OCPS using GOX pressure decay method.			X		X	
f. Leak check D/S OCPS using GOX pressure decay method.				X	X	
g. Leak check mated OCPS at operating pressure with GOX using pressure decay.						
2.3.3.3. Verify Internal Leakage.						
a. Leak check DESC and ASC oxygen shutoff valves at maximum operating pressure using fluid displacement method.			X			

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	
				NON-FEAT	FEAT
b. Leak check oxygen demand regulators A and B in closed, cabin and egress positions using fluid displacement method.	X				
c. Leak check PLSS O ₂ valve at operational pressure using fluid displacement method.	X				
2.3.4. Functionally Test OCPS O ₂ Control Assembly.					
2.3.4.1. To Verify the Oxygen Compatability.					
a. Pressure A/S OCPS to operating pressure using gaseous oxygen.	X				
b. Pressurize D/S OCPS, to operating pressure using gaseous oxygen.	X				
2.3.4.2 Service OCPS.					
a. Evacuate and fill D/S & A/S GOX tank with gaseous oxygen.					X
b. Verify oxygen quantity display at various levels of fill.					X
2.3.4.3 Functionally Check OCPS.					
a. Verify performance of A/S O ₂ regulators in Cabin & Egress modes.	X				X

TEST OBJECTIVES	BPA				KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
b. Verify performance of Cabin Repressurization & Emergency O ₂ valve.	X				X	
c. Verify electrical controls of Cabin Repressurization & Emergency O ₂ valve.					X	
d. Verify A/S GOX tanks low level C/W.					X	
e. Verify D/S GOX tank low level C&W.					X	
f. Verify A/S #1 & #2 tank less than full C/W.					X	
g. Recharge PLSS.					X	
h. Verify OCPS Operational Instrumentation.	X	X			X	
2.3.5 Atmosphere Revitalization Section. (ARS)						
2.3.5.1 To Verify Structural Integrity.						
a. Proof pressure test ARS.						
2.3.5.2 To Verify External Leakage of ARS.						
a. Leak check ARS SCA using flow meter make-up method.					X	

TEST OBJECTIVES	BPA				KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
2.3.5.3 ARS Functional.						
a.	Evacuate suit loop, and turn-on and verify suit fans and water separators at cabin & egress pressures and at various back pressures.			X	X	
b.	Simulate suit fan & water separator failures and verify component lights and C&W.			X	X	
c.	Introduce water vapor to evacuated suit loop and verify water separator removal capabilities.			X	X	
d.	Introduce CO ₂ to evacuated suit loop & verify CO ₂ partial pressure component light & CO ₂ display.			X	X	
e.	Evacuate suit loop and verify performance of suit isolation valves and C&W.			X	X	
f.	Turn-on and verify cabin fans at reduced GSE voltage.			X	X	
g.	Verify electrical interface between cabin fans, cabin pressure switch and oxygen regulators.			X	X	

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	NON-FEAT
h. Verify operation of cabin temperature control.				X		X
i. Verify operation of suit temperature control & suit circuit regenerative heat exchanger.				X		X
j. Turn-on and verify suit fans and water separators.				X		X
k. Turn-on and verify cabin fans.				X		X
l. Verify performance of LiOH cartridges.					X	X
m. Verify water removal performance of water separators.				X		X
n. Replace LiOH cartridges in suit circuit assembly and PLSS.					X	X
o. Install and remove LiOH cartridges in suit circuit assembly.					X	X
p. Verify operation of suit circuit diverter valve as a function of O ₂ regulator positions.					X	X
q. Verify operation of cabin gas return valve.				X		X

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
r. Verify ARS Operational Flight Instrumentation.					X	X	X
s. Verify tensile strength of CDR's and LMP's O ₂ umbilical by performing a post installation pull out.							X
2.3.6 LM Cabin.							
2.3.6.1 To Verify Structural Integrity.							
a. Proof pressure test cabin.					X		
b. Flt check NAA drogue.					X		X
2.3.6.2 Verify External Leakage of Cabin.							
a. Leak check cabin using GN ₂ flow meter make-up method.					X		X
2.3.6.3 Functional Test.							
a. Functionally test cabin pressure relief dump valves.					X		X
b. Verify cabin pressure and temperature displays.					X		X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	CCU/D FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
2.3.6.4 Servicing.						
a.	Purge cabin to obtain required GN ₂ concentration. (O ₂ used in altitude test at 5000 feet).			X		
b.	Turn on suit fan during cabin purge to ensure oxygen purge of suit loop.			X		
2.3.6.5 Hatch Test.						
a.	Verify proper operation of upper docking hatch, relief valves and locking torque.	X				
b.	Verify proper operation of forward ingress/egress hatch, relief valves and locking torque.	X		X		
2.4	GUIDANCE AND NAVIGATION.					
2.4.1	General Turn-On.			X	X	
a.	Energize IMU standby, LGC operate & self-test.					

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
			A/S	D/S	A/S	D/S	
	BPA		A/S	D/S	NON-FEAT	FEAT	
2.4.2 Standby Power On Test.					X	X	X X
a. Verify DSKY generates power commands to electroluminescent elements.					X	X	X X
b. Verify that the LGC correctly performs arithmetic functional and parity checks.					X	X	X X
2.4.3 Alarms and Interrupts Test.							X X
a. Alarm and interrupt conditions are checked in conjunction with DSKY or K start commands.							X X
2.4.4 IMU Operate Power-On Test.							X X
2.4.5 Temperature Control Verification.							X X X
a. Verify that all G&N power supplies and temperature controls turn on.							X X X
b. Verify IMU temperature control.							X X X
2.4.6 PGNCS Power Supply Tests.							X X X
a. Verify 28, 14V & 4VDC at each respective G&N power supply.							X X X

TEST OBJECTIVES	PLANNED	COLD FLOW				FINAL ASSEMBLY				KSC	
		A/S	D/S	A/S	D/S	MATED					
						NON-FEAT	FEAT				
b. Verify G&N 800 and 3200 CPS power supplies.						X	X				
2.4.7 IMU Operational Test.						X	X				
a. Verify CDU ZERO - coarse align and fine align modes.						X	X				
b. Verify PIMA loop operation by means of LGC computation of local gravity. (Gross PIMA verification).						X	X				
c. Verify IRIG's ability to maintain inertial reference.						X	X				
2.4.8 PGNCs Operational Test.						X	X				
a. Verify attitude control outputs.						X	X				
b. Verify mode control switch in off position.						X	X				
c. Verify function of G&C switch.						X	X				
2.4.9 IRIG Scale Factor Test.								X			
a. Utilizing the LGC denote the torque pulse relationship to a specified gimbal movement.									X		

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY			KSC
	A/S	D/S	A/S	D/S	MATED	
	A/S	D/S	NON-FEAT	FEAT		
2.4.10 IMU Performance Test.			X			
	a.	Verify PIPA loop operation by means of LGC computation of local gravity (Fine PIPA verification).			X	
	b.	Utilizing the LGC determine the three IRIG non-acceleration sensitive drift coefficient and six IRIG acceleration sensitive drift coefficients 30 to 60 day intervals.		X		
2.4.11 LGC Voltage Margin Test.					X	
	a.	Verify voltage operating range of +4 and +14 VDC.		X		
	b.	Verify operation of LGC self check program.		X		
2.4.12 LGC Clock Frequency Test.					X	
	a.	Verify frequency of 2V 3200HZ PSA power supply.		X		
2.4.13 Gimbal Friction Test.					X	
	a.	Verify IGA, MGA, OGA friction.		X		

TEST OBJECTIVES	PLANNED		COLD FLOW				FINAL ASSEMBLY				KSC	
			A/S	D/S	A/S	D/S	MATED					
							NON-FEAT	FEAT				
2.4.14 Stabilization Loop Response Test.							X			X		
	a.	Monitor IGA, MGA, OGA servo error and torque drive signals.										
2.4.15 G&N Fine Alignment Test.	a.	Align IMU to LGC commanded orientations.					X			X		
	b.	Monitor PIPA outputs to determine accuracy of alignment.					X	X		X		
2.4.16 AOT Functional Accuracy Test.												
	a.	Provide inputs from AOT sightings of known earth references in each of its 3 detent positions.					X			X		
	b.	Measure AOT shaft and trunnion angle for each sighting.					X			X		
	c.	Calculate AOT line of sight angles. (X1 and X2)					X			X		
	d.	Using AOT shaft and trunnion angle measurements and manufacturer's calibration data, have LGC compute AOT line of sight angles.								X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW			FINAL ASSEMBLY			
A/S	D/S	A/S	D/S	... ATED	NON-FEAT	FEAT	
e. Compare calculated and computed sight angles.				X	X		X
f. Verify AOT MARK X&Y and reject discretes to LGC.				X	X		X
2.4.17 Memory Bank Sum Check & Retention.					X		X
a. Verify that the fill & retraction of data from the erasable memory is correct via ACE-S/C.					X		X
b. Cycle power on and off and check effect on E-memory retention.					X		X
2.4.18 G&N/Vehicle Interface Checks						X	X
a. Verify LGC/CWEA interface.						X	X
b. Verify LGC/CES interface.						X	X
c. Verify LGC/RCS control.						X	X
d. Verify PGNS cabin displays interfaces.						X	X
e. Verify mode control switch.						X	X
f. Verify guidance control switch function PGNS to AGS.						X	X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	NON-FEAT
g. Verify LGC/Manual controller interface.					X	X
2.4.19 LGC Clock Align.					X	X
2.4.20 PGNS Shutdown.					X	X
a. Verify gimbal parking.					X	X
b. Remove IMU operate, LGC/DSKY and IMU standby power.					X	X
c. Verify transfer of control of IMU heater power to PTC.					X	X
2.5 RENDEZVOUS RADAR.					X	X
2.5.1 RR Turn-On and Self Test.					X	X
a. Turn on RR.					X	X
b. Activate RR self test.					X	X
c. Monitor transmitter output power.					X	X
d. Monitor AGC loop signal strength.					X	X
e. Monitor shaft and trunnion error signals.					X	X
f. Monitor range and range rate signals.					X	X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW	FINAL ASSEMBLY	A/S	D/S	A/S	D/S
					MATED	NON-MATED
g. Verify mechanical unstowing of RRAA. (Alt. Chamber).					X	
2.5.2 RR Antenna Angular Coverage and Slew Test.						
a. Verify antenna shaft and trunnion angular limits.					X	X
b. Verify antenna slew rates, and antenna slew polarity.					X	X
2.5.3 RR RF Transmitter and Receiver Test.					X	X
a. Verify transmitter power output.					X	X
b. Monitor output frequency.					X	X
c. Monitor transmitter output for spurious content.					X	X
d. Calculate tone mod. indices.					X	X
e. Verify 6.8 MC out of freq. sync.					X	X
f. Verify 1.7 MC received.					X	X
g. Monitor AGC response.					X	X
h. Monitor no track indication.					X	X

TEST OBJECTIVES	PLANNED		BPA		KSC
	COLD FLOW		FINAL ASSEMBLY		
	A/S	D/S	A/S	D/S	MATED
1. Measure RR acquisition time.				X	X
j. Measure static and dynamic range rates.				X	X
k. Measure MDS.			X	X	X
2.5.4 LGC Interface Test.				X	X
a. Verify RR range & range rate signals.				X	X
b. Monitor LGC for range outputs.				X	X
c. Verify lo scale factor switching.				X	X
d. Verify RR CDU fail.				X	X
e. Verify that the LGC designate signals drive the RRAA in trunnion and in shaft.				X	X
f. Monitor angle readouts.				X	X
g. Verify R-04 self-test routine.				X	X
2.5.5 RR Power Supply Tests.				X	
a. Measure Prime LGC 800 Hz Signal.				X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
			A/S	D/S	A/S	D/S	
			MATED		NON-FEAT	FEAT	
b. Measure ϕ_A & ϕ_B 800 Hz signal.					X		X
c. Measure DC signal.					X		X
2.5.6 RR Gyro Torquing Test.					X		X
a. Monitor Gyro compensated outputs.					X		X
b. Repeat test for redundant pair of Gyros.					X		X
2.5.7 RR Pointing Accuracy.							
a. Verify RR self test.						X	X
b. Optically align RR to range signal source.						X	X
c. Verify X-Band source transmitted signal.						X	X
d. Verify RR lock on.						X	X
e. Pointing error, bias error, random error, and delta bias error will be monitored.						X	
2.5.8 RR Angle Tracking Test.						X	X
a. Verify initial acquisition and lock on.						X	X
b. Slew positioner off boresight.							X

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
			A/S	D/S	A/S	D/S	
							MATED
c.	Verify radar re-acquisition.					X	X
	d.	Monitor and evaluate error signals.				X	X
	e.	Verify RR acquisition and re-acquisition.				X	X
2.5.9	RR Closed Loop Servo Test.					X	X
	a.	Mechanically torque RR AA on LM mockup.					
	b.	Verify ability of RR AA to stabilize itself.					
2.5.10	RR System Drift Test.				X		
	a.	Measure RR System Drift rate.					
2.5.11	RR Range Measurement.				X		
	a.	Verify RR lock on (acquisition time), and Monitor RR range.					
	b.	Compare with surveyed range.				X	
2.5.12	Transponder RF Test.					X	
	a.	Monitor transmitter power output.					
	b.	Monitor transmitter frequency.				X	

TEST OBJECTIVES	PLANNED		BPA		KSC		
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	FEAT
c. Monitor for modulation index.					X		
d. Monitor RF sweep range.					X		
e. Measure system sensitivity. (MDS)					X		
f. Measure acquisition time.					X		
g. Check AGC curve.					X		
2.5.13 RR/T Compatibility Test.					X		
a. Initiate Transponder acquisition by RR.					X		
b. Measure range and range rate.					X		
c. Monitor sys. acquisition time.					X		
d. Monitor system acquisition threshold level.					X		
2.5.14 RR Auto Ascent Profile.					X	X	X
a. Verify LGC designates via K-Start-Monitor shaft and trunnion angle readings.							
b. Verify range rate in discrete steps (-4900 to 4900fps) - Monitor RR and LGC range output.							X

TEST OBJECTIVES	PLANNED		BPA		KSC
	COLD FLOW		FINAL ASSEMBLY		
	A/S	D/S	A/S	D/S	MATED
					NON-FEAT
					FEAT
c. Verify closing ramp, at -1000 fpm closing Rates At 3 Starting Ranges & Power Levels.					
	<u>PWR Levels</u>				
	NM				
	350	400 NM			
	150	150 NM			
	60	60 NM			
	-Monitor RR range output (via LGC).				
	d. Verify acquisition time, and acquisition threshold.				
2.5.15	Verify Mechanical Alignment of R. R. Base to NAV Base.				
2.5.16	RR Antenna Heater Check.				
	a. Monitor antenna temperature.				
	b. Monitor heater operation.				
2.5.17	RR Shut-Down.				
	a. Turn off all CB's associated with the R. R.				

PLANNED TEST OBJECTIVES		BPA		KSC	
CO2/D FLOW		FINAL ASSEMBLY			
		A/S	D/S	A/S	D/S
				MATED	NON-FEAT
2.6	LANDING PAD/R.			X	X
2.6.1	LR Turn-On and Self-Test.			X	X
	a. Turn-on and activate L. R. self-test.			X	X
	b. Monitor transmitted power output.			X	X
	c. Monitor altitude & altitude rate.			X	X
	d. Monitor forward and lateral velocities.			X	X
2.6.2	RF Power Measurement.			X	X
	a. Measure velocity transmitted power.			X	X
	b. Measure range transmitted power.			X	X
	c. Monitor range and verify transmitter detected power in LM cabin area at GSE.			X	X
	d. Measure velocity and altimeter transmitter frequencies.			X	X
2.6.3	Acquisition Threshold and Acquisition Probability.			X	
	a. Measure acquisition threshold.				

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	NON-FEAT
b. Measure Acquisition probability.					X	
2.6.4 Gain State Switching.					X	X
a. Monitor beam attenuation.					X	X
b. Observe gain state switching.					X	X
2.6.5 L. R. Internal Power Check.					X	
1. Verify proper operation of L. R. power supplies.					X	
2.6.6 Antenna Switching.					X	X
a. Switch antennas via ACE K-start.					X	X
b. Switch antennas manually.					X	
c. Monitor antenna position at ACE.					X	X
2.6.7 Self-Test Frequencies.					X	
a. Monitor LR self-test frequencies.					X	
2.6.8 Preamp Noise and Cross Talk Check.					X	
a. Measure preamp noise amplitude.					X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
			A/S	D/S	A/S	D/S	
	BPA						
b. Measure preamp signal leakage.						X	
2.6.9 LR Portion of PGNS Auto Descent Profiles.						X	X
a. Monitor LR and LGC velocity outputs.						X	X
b. Monitor LR and LGC range outputs.						X	X
c. Verify LR antenna tilt.						X	X
2.6.10 L/R Antenna Heater Check.						X	X
a. Monitor antenna temperature.						X	X
b. Monitor Heater operation.						X	X
2.6.11 Verify Mechanical Alignment of L.R. A.A. to NAV BASE.						X	X
2.6.12 L/R Shut Down.						X	X
	Turn off all CB's associated with L.R.						
2.7 STABILIZATION AND CONTROL.							
2.7.1 Control Power Turn-On and Verification.							
a. Verify power turn-on before commencing checkout of stabilization and control subsystem.						X	X

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		BPA KSC
	A/S	D/S	A/S	D/S	MATED	NON- FEAT	
						FEAT	
2.7.1.1 AGS Turn-On.					X	X	X
	a.	Monitor and record ASA block temperature.			X	X	X
	b.	Monitor and record ASA gyro run-up time.			X	X	X
	c.	Verify "Operate Mode" ASA, DEDA and clock outputs.			X	X	X
	d.	Verify DEDA voltages.			X	X	X
	e.	Verify presence of ASA accelerometer and gyro pulse counts.			X	X	X
	f.	Verify presence of ASA gyro SMKID pulses.			X	X	X
	g.	Verify AGS Status via down link.			X	X	X
	h.	Monitor & record ASA gyro run-down time.			X	X	X
	i.	Verify ASA pulses received by AEA.			X	X	X
2.7.1.2 CES Turn-On.							
	a.	Verify voltages (ATCA) via power failure indicators.				X	X
	b.	Verify RGA SMKID pulses.				X	X

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	
				NON-FEAT	FEAT
c. Verify RGA run-up time.				X	X
d. Perform self-test.				X	X
e. Record RGA run-down time.				X	X
2.7.2 Verify DEDA Functions.				X	X
a. Verify DEDA keyboard functions.				X	X
b. Verify operator error and clear functions.				X	X
c. Verify DEDA lighting and EL segments.				X	X
d. Verify DEDA/AEA communications.				X	X
2.7.3 Verify AEA Computer Self Checks.				X	X
i. Logic and instruction self-test.				X	X
j. Memory address test.				X	X
k. Memory noise self-test.				X	X
l. Sum check.				X	X
m. AGC Accelerometer & gyro drift input register check.				X	X
n. AGS memory dump.				X	X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
2.7.4 Check Operation of AGS Align Modes.						
2.7.4.1 DNU Align Submode.						
					X	
					X	
					X	
2.7.4.2 State Vector Transfer.						
					X	
					X	
					X	
					X	
2.7.4.3 Body Axis Align Submode (Orbital Align).						
					X	
					X	

TEST OBJECTIVES	PLANNED		BPA		KSC	
	LOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	NON-FEAT
2.7.4.4 Lunar Align Submode.					X	X
a. Monitor AGS downlink to verify that AGS Lunar alignment submode is functioning properly.					X	X
2.7.5 Verify ASA/IMU Alignment.					X	X
a. Verify that the difference between the inertial measurements of ASA and IMU level is within specified limits.					X	X
2.7.6 AEA Flight Program Entry and Verification.					X	X
a. By means of the EPC program, determine the ASA gyro drift readings.					X	X
b. Enter the flight program into the AEA erasable memory.					X	X
c. Verify the flight program entry.					X	X
d. AGS sim. flight.					X	X
e. AEA digital downlink verification.					X	X
f. Perform AGS earth pre-launch calibrate check.					X	X

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY		MATED	NON-FEAT	FEAT
	A/S	D/S	A/S	D/S			
g. Compare AEA memory dump Vs TRW binary card decks, AEA ACE file tapes and ACE master tapes.							X
h. Verify AEA memory integrity during simulated staging.							X
2.7.7 ASA Parameter Verification.							X
	a.	The ASA inertial parameters cannot be determined in the vehicle; during the shipping and waiting time preceding the tests noted, the ASA shall be removed from the vehicle and returned to the MSOB inertial test facility for parameter evaluation. It is desired that this process be repeated at approximately 30-day intervals during the test cycles preceding launch.				X	
	b.	In-vehicle accelerometer & gyro measurements.					X
	c.	ASA to AEA digital continuity.					X
2.7.8 AGS/CES Threshold Verification.							X
	a.	Verify proper AGS/CES functional operations by monitoring AGS/CES response to earth's rate input.					X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	
					NON-FEAT	FEAT
2.7.9 ACS/Display Interface Verification.					X	X
b. Verify RCS firing functional.						X
a. Verify AGS/FDAI total attitude display interface.					X	X
b. Verify AGS/FDAI steering error display interface.					X	X
c. Verify AGS/Altitude and altitude rate display meter interface.					X	X
d. Verify AGS/Lateral velocity interface.					X	X
e. Verify AGS/cross pointer display.					X	X
f. Verify AGS input/output discretes.					X	X
2.7.10 CES Functional Verification.						
2.7.10.1 Verify the following CES Parameters or Functions.						
a. Attitude signal limiting (Ascent and Descent).						X
b. Attitude control deadband (narrow and wide deadband).						X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
c. Attitude control loop offset.				X	X	
d. Attitude rate gain.				X	X	
e. EMI characteristics.				X	X	
f. Pulse mode characteristics.				X	X	
g. Gimbal trim threshold.				X	X	
h. Gimbal trim rate.				X	X	
i. Manual throttle control.				X	X	
j. Attitude gain.				X	X	

2.7.10.2 Verify the following CES Logic and Switching Functions.

- RCS jet logic with AEA steering error inputs.
- RCS jet logic with ACA rate command inputs.
- RCS jet logic with T/TCA translation inputs.
- RCS jet logic with RGA rate inputs.
- RCS jet logic with 4-Jet select switch inputs.

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY			KSC
	A/S	D/S	A/S	D/S	MATED	
					NON-FEAT	
f. RCS jet logic with balanced coupling switch inputs.					X	X
g. Gimbal trim malfunction logic.					X	X
h. ACA/Secondary solenoid interface in 2-Jet and 4-Jet control.				X	X	X
2.7.10.3 Verify CES Descent Engine Control Functions.						
a. Verify automatic engine on/off control.					X	X
b. Verify engine arm, start, stop, abort, abort stage (Manual).					X	X
c. Verify Descent Engine Override.					X	X
d. Lumar contact logic.					X	X
2.7.10.4 Verify Ascent Engine Control Functions.						
a. Verify engine automatic engine on/off and abort stage control.					X	X
b. Verify engine arm, start, stop (manual).					X	X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	
2.7.10.5 Verify CES/Display Interfaces.					X X	X X
a. Attitude rate display interface.					X X	X X
b. Manual thrust display interface.					X X	X X
2.7.10.6 Verify the following CES Discretes.					X X	X X
2. ACA out-of-detent to AEA.					X X	X X
b. ACA out-of-detent to LGC.					X X	X X
c. Ascent and Descent Engine on to AEA.					X X	X X
d. Start Abort Stage Program to AEA & LGC.					X X	X X
e. Start Abort Program to AEA and LGC.					X X	X X
f. Ascent and Descent Engine armed to LGC.					X X	X X
g. Auto, Attitude hold discrete to AEA.					X X	X X
h. Guidance select switch discrete to AEA (follow-up).					X X	X X
i. Auto stabilization and attitude hold discretes to UGC.					X X	X X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/E	D/S	A/S	D/S	MATED	
					NON-FEAT	FEAT
2.7.10.7 Verify RGA & ASA Polarity.				X	X	
a. Verify the RGA polarity by rotating the vehicle and verifying proper RCS thruster response to RGA sensed rate inputs.				X		
b. Verify the ASA polarity by rotating vehicle & verifying proper RCS response.				X		
2.7.11 Ordeal.					X	
a. Verify Functional Performance.					X	
b. Verify crew interface.					X	
2.7.12 PIUS Functional Interface Tests.						
a. LGC/Descent Engine on/off Auto.					X	
b. LGC/Descent Engine Throttle.					X	
c. LGC/Descent Engine Gimbal Trim.					X	
d. LGC/Ascent Engine on/off (auto).					X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
2.8 REACTION CONTROL SUBSYSTEM.							
2.8.1. RCS Liquid Flush.							
a. Verify the cleanliness level of RCS propellant manifolds by flushing with Freon TF.					X ₁ *	X ₁ *	
b. Dry manifolds subsequent to Freon flush.					X ₁ *	X ₁ *	
c. Verify cleanliness of RCS propellant tanks by flushing with Freon TF.					X ₁ *	X ₁ *	
d. Dry propellant tanks subsequent to Freon flush.					X ₁ *	X ₁ *	
2.8.2 RCS Proof Test.							
a. Proof pressurization of He Module and Propellant tanks.					X ₁ *	X ₁ *	
b. Proof pressurization of propellant manifolds.					X	X	
2.8.3 RCS Valve Response.							
a. Obtain oscilloscope records of voltage transients occurring across the 32 fuel and oxidizer thruster solenoid secondaries during ATCA, PGNS and ACA excitation.					X	X	X

*X₁ - MFG. PLANT 2

TEST OBJECTIVES	PLANNED		BPA		KSC
	COLD FLOW		FINAL ASSEMBLY		
	A/S	D/S	A/S	D/S	MATED
					NON-FEAT
					FEAT
b. Measure absolute and skew time delays of RCS thruster response to commands.				X	
c. Verify, electrically, the operation of the RCS propellant valves and their position signals to the cabin flags and via TM to ACE-S/C displays.				X	
2.8.4 RCS Thrusters Heaters Functional Test.				X	
a. Verify operation of the primary and secondary thruster cluster heater assemblies, check operation of heaters by current measurements.				X	
b. Correlate thruster cluster temperature readings using GSE thermocouples versus cabin display readouts and ACE readouts.				X	
c. Verify auto & manual modes.				X	
2.8.5 RCS - Fluid Systems Test, Harness Electrical Check & Dry Structural Integrity Test.				X	
a. Verify vehicle GSE interface compatibility of electrical wiring harness.					

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	NON-FEAT
b. Verify response of components to electrical control signals.	X				X	
c. Verify structural integrity of system.	X				X	
2.8.6 RCS Pressurization and Feed System Functional and Leak Check						
a. Perform an external leak check of He tanks, pressurization system and propellant system to main shut off valves. Check internal leakage of initiating valves.	XX ₁ *				X	
b. Check leakage past burst disc & overall quad check valve internal leakage. (Leak check individual quad check valve elements BPA only).	XX ₁ *				X	
c. Leak check propellant tank bladders.	XX ₁ *				X	
d. (Perform relief valve functional (cracking & reseat pressures) - BPA only). Check valve functional (cracking pressure of each individual valve including bleed valves) and regulator functional tests.	XX ₁ *				X	
e. Check internal leakage of main shut off valves.	XX ₁ *				X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
f. Check internal leakage of RCS-Ascent Interconnect valves.	XX ₁ *				X		X
g. Perform an external leak check of the propellant feed section	X				X		X
h. Leak check crossfeed valves and isolation valves.	X				X		X
i. Check pressure & temperature instrumentation.	X ₁ *				X		X
j. Check operation of RCS - Ascent inter-connect valves.	XX ₁ *				X		X
k. Leak check TCA injector valves.	XX ₁ *				X		X
1. Parker valves latch force test.	XX ₁ *				X		X
2.8.7 RCS Subsystem Pressure Decay Test.							
a. Verify pressure integrity of complete reaction control subsystem (RCS) by pressure decay.	X						
2.8.8 RCS Engine Functional Tests.							
a. Verify TCA injector valve flow rates are within limits.	X						

* X₁ - MFG. PLANT 2

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC	
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	FEAT	
b. Perform a flow test of the TCA injector orifices.					X		X	
c. Verify valve signatures.					X		X	
d. Check operation of chamber pressure switches.		X			X			
e. TCA alignment check.			X					
2.8.9 RCS Subsystem & FCS Integrated Checkout						X		
a. Verify FCS/RCS operation all modes. Both guidance systems.								
f. Verify TCA injector valve sequencing and response times (primary & secondary coils).						X		
2.8.10 Hypergolic Servicing.								
a. Service RCS propulsion system including the propellant manifolds up to isolation valves.						X		
b. Interconnect valve leak check.							X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
2.8.11 RCS Quick Disconnect Leak Checks.					X		
a. Leak check QD's after final use - caps on and off.							
2.8.12 Helium Servicing RCS.							
a. Load RCS He tanks.							
2.8.13 Tank Pressure Cycling Limitations (See TSCD).							
2.9 PROPULSION SUBSYSTEM.							
2.9.1 D/S Fluid System Test, Harness Electrical Check & Propulsion Dry Structural Integrity Test.							
a. Verify vehicle - GSE interface compatibility of electrical wiring harnesses.							
b. Verify responses of fluid control & monitoring devices in D/S prop. & subsystems to known stimuli, and identify sensor output channels at A/S - D/S interface.							

TEST OBJECTIVES	PLANNED		COLD FLOW				FINAL ASSEMBLY				KSC
	A/S	D/S	A/S	D/S	MATED						
						NON-FEAT	FEAT				
c. Pressurize propellant section, high pressure, helium manifold and SHe storage section, to establish confidence level in the structural pressure integrity, of the D/S Fluid lines and tanks prior to performing subsequent cold flow OCP's.											
2.9.2 Low Pressure D/E Interface Leak Check.											
a. Leak check the descent engine/feed section fluid line interfaces.	X				X						
b. Leak check all fluid line connections and brazed caps between vehicle and descent engine.		X				X					
2.9.3 D/S Propulsion Subsystem Proof Pressure, Fluid, Leak & SHe Tank Leak Tests.											
a. Verify structural integrity of all connections between plumbing lines and pressurization modules by subjecting that section to a proof pressure.					X						
b. Verify structural integrity of SHe tank and high pressure manifold by subjecting that section to proof pressure.						X					

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
c. Verify structural integrity of propellant storage tanks and feed section by subjecting that section to proof pressure.		X			X		
d. External leak test SHe tank, ambient helium tank, high and low pressure manifolds down to the top of propellant tanks after proof test.		X			X		
2.9.4 D/S Internal Component Leak Checks.							
e. Verify that internal leakages across latching solenoid valves are within allowable limits.		X			X		
b. Verify that internal leakage across Quad check valves and burst disks, are within allowable limits.		X			X		
c. Verify that internal leakage across lunar dump Squib valves are within allowable limits.		X			X		
2.9.5 D/S Propulsion Subsystem, Ambient He Purge & Dry Leak Check at Operating Pressures.							
a. Remove GN ₂ blanket from SHe tank and replace with GHe blanket.		X					

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
b. Remove GN ₂ blanket from D/S propellant feed section and replace with GHe blanket.	X						X
c. Verify external leakage integrity of hardware associated with SHe tank assembly.	X						X
d. Verify external leakage integrity of high pressure He manifold and associated hardware.	X						X
e. Verify external leakage integrity of propellant feed section and associated hardware.	X						X
2.9.6 D/S Substitute Propellant Cold Flow Test.							
a. Hydraulically balance the D/S propellant feed system.	X						
b. Demonstrates performance characteristics of vehicle He regulators at a predetermined inlet pressure.	X						
c. Demonstrate performance characteristics of pressurization and propellant feed system with supercritical He.	X						

TEST OBJECTIVES	PLANNED	COLD FLOW				FINAL ASSEMBLY				KSC
		A/S	D/S	A/S	D/S	MATED	NON-FEAT	FEAT		
2.9.7	D/S Propellant Feed Section, Dry and Sample.								X	
	a. Flush and dry propellant tanks and feed section upon completion of Cold Flow testing.									
	b. System cleanliness will be verified by sampling fuel flush fluid effluent from propellant tanks.		X							
	c. Ensure subsystem cleanliness by establishing a positive GN ₂ blanket pressure within the LM descent propulsion subsystem.		X							
2.9.8	A/S Pressurization & Propellant Feed Systems Proof Pressure & Leak Checks at Operating Pressure.								X	
	a. Verify structural integrity of A/S pressurization section when subjected to proof pressure.								X	
	b. Verify structural integrity of A/S propellant feed sections when subjected to less than proof pressure.								X	

TEST OBJECTIVES	PLANNED		BPA		KSC
	COID FLOW		FINAL ASSEMBLY		
	A/S	D/S	A/S	D/S	MATED
					NON-FEAT
c. Internal leak check regulator.	X				X
d. Verify cracking and reseating of relief valves.	X				X
e. Verify that internal leakage across Squib valves, check valves, relief valves, and relief valve burst discs is within allowable limits.					X
f. Verify that external leakages in the helium high and low pressure section and propellant feed section are within allowable limits at full operating pressure.		X			X
2.9.9 A/S - Internal Component Pneumatic Leak Test After Substitute Cold Flow Test.					X
a. Verify that internal leakage across the solenoid valves, check valves, and burst discs are within allowable limits after completion of Cold Flow Test.					X
2.9.10 A/S Propulsion Subsystem Dry Leak Check.					X
a. Check external leakage of brazed and mechanical propellant feed system joints downstream of propellant tanks.					X

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC	
			A/S	D/S	A/S	D/S		
	BPA						NON-FEAT	FEAT
2.9.11 A/S Substitute Propellant Cold Flow Test.								
a. Hydraulically balance the LM A/S propellant feed system.		X						
b. Demonstrate that the He gas system can perform satisfactorily using various modes of regulation.		X						
c. Determine regulator starve out point, and decay mode characteristics.		X						
2.9.12 A/S Propellant Feed Section Dry and Sample.								
a. Dry propellant tanks and feed section upon completion of cold flow testing.		X						
b. System cleanliness will be verified by sampling fuel fluid from propellant tanks.		X						
c. Ensure subsystem cleanliness by establishing a positive GN ₂ blanket pressure within the ascent propulsion subsystem.		X						

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC	
	A/S	D/S	A/S	D/S	MATED	NON-FEAT		
					FEAT			
2.9.13 A/S Propellant Low Level Indication and D/S Propellant Quantity Gaging System Verification.					X	X	X	
a. Verify performance of D/E propellant quantity gaging system control unit.					X	X	X	
b. Verify D/S PQGS control unit telemetry outputs and cabling interfaces with ACE-SC.					X	X	X	
c. Verify D/S PQGS sensor circuitry.					X	X	X	
d. Verify operation of D/S PQGS cabin display.					X	X	X	
e. Verify operation of A/E & D/E propellant low level sensors under empty tank conditions via ACE-S/C telemetry downlink.					X	X	X	
2.9.14 A/S Propulsion System Verification.								
a. Verify relief valve functional operation.					X		X	
b. Verify functional operation of regulators.					X		X	
c. Leak check engine ball valves and pre-valves.					X		X	

TEST OBJECTIVES	BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY	
	A/S	D/S	A/S	D/S
			MATED	NON-MATED
			FEAT	FEAT
d. Verify the internal leakage across S/O valves, squib valves, He regulators, and quad check valves is within allowable limits.	X			X
e. Verify external leakages in all new brazes and mechanical joints in the high and low pressure sections and propellant feed section of the A/S are within allowable limits.	X			X
2.9.15 D/S Propulsion System Verification.				
Verify that the D/S propulsion system is ready for shipment to KSC by performing following tests.				
a. SH _e tank heat leak check.	X			
b. External leak tests SH _e tank, ambient helium tank and new brazed fittings and mechanical fittings.		X		X
c. Internal leak check of relief valves, squib valves, quad check and solenoid latching valve.		X		X
d. Helium regulator functional and creep test.		X		X

TEST OBJECTIVES		COLD FLOW		FINAL ASSEMBLY		BPA	KSC
		A/S	D/S	A/S	D/S	MATED	NON-MATED
e.	Leak check engine ball valves.		X		X	X	X
f.	Engine pre-valves thermal relief and internal leak check.		X		X	X	X
2.9.16	A/S Propulsion Electrical Valve Functional Verification.					X	X
a.	Verify functional status of electrically controlled solenoid valves within the A/S propulsion fluid lines.				X	X	X
2.9.17	D/S Engine Functional and Gaseous Blowdown Check.				X	X	X
a.	Verify functional operation and leakage integrity of D/E.				X	X	X
b.	Ascertain that propellant feed section & D/E propellant passages do not have restrictions.				X	X	X
c.	Verify proper operation of thermal relief capability of engine pre-valves and check internal leakage of pre-valves.				X	X	X
d.	Verify proper operation of descent propulsion instrumentation.				X	X	X

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
					MATED	
					NON-FEAT	
					FEAT	
e. Monitor ball valve full open positions pneumatically.			X		X	
2.9.18 A/S Engine Interface Leak Check - Low Pressure.						
a. External leak check all fluid line connections between vehicle and ascent engine.			X		X	
b. External leak check brazed caps installed after cold flow tests.			X		X	
2.9.19 Ascent Engine Functional and Gaseous Blow-down Check.						
a. Verify functional operational and leakage integrity of ascent engine.			X		X	
b. Verify proper operation of thermal relief capability of engine pre-valves; check internal leakage of pre-valves.			X		X	
c. Ascertain that propellant feed section and ascent engine propellant passageways do not have any restrictions.			X		X	
d. Verify proper operation of applicable ascent propulsion instrumentation.			X		X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
			A/S	D/S	A/S	D/S	
						NON-FEAT	FEAT
2.9.20 A/S Fluid Systems Test Harness Electrical Check.					X		
	a.	To demonstrate compatibility of the vehicle in facility electrical interface.					
	b.	To verify proper response of subsystem components to electrical control signals.			X		
	c.	To verify response of subsystem instrumentation to ambient conditions.			X		
2.9.21 Servicing.						X	
	a.	A/S, D/S hypergolic loading				X	
	b.	SHe loading.				X	
	c.	A/S, D/S helium tank loading.				X	
	d.	Service RCS helium tanks.				X	
2.9.22 Propulsion Related Displays.						X	X
	a.	Verify indicator - thrust display.				X	
	b.	Verify meter - thrust/wt ratio.				X	

TEST OBJECTIVES	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
					FEAT	FEAT	
c. Verify indicator - eng. fuel and oxidizer press.					X	X	X
d. Verify indicator - eng. fuel and oxidizer press.					X	X	X
2.10 EXPLOSIVE DEVICES SUBSYSTEM.							
2.10.1 ED Bridgewire and Installation Resistance Tests.							
a. To verify the electrical integrity of the bridge wire circuits of the end detonator, and cartridges by measuring the bridgewire and insulation resistances.							
2.10.2 Explosive Component Resistance Checks (After Installation).							
2.10.3 ED Bus Verification After Explosive Device Battery Installation.							
2.10.4 End Detonator Performance Demonstration.*							
a. To verify that the end detonator will fire with minimum all fire current applied to bridgewire.							
b. To verify that the end detonator will cause specified indentation of a standard test plate.							

*Performed 30 days or less prior to launch - off line.

	TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		BPA	KSC
		A/S	D/S	A/S	D/S	MATED	NON-MATED		
2.10.5	c. Verify the post fire circuit status.							X	
	LM Standard Cartridge Performance Demonstration.*								
	a. To verify that the cartridge will fire with minimum all fire current applied to the bridgewire.							X	
	b. To verify the cartridge output pressure vs time.							X	
	c. To verify the post fire circuit status.							X	
2.10.6	Guillotine Cutter Performance Demonstration.*								
	a. To verify that the guillotine cable cutter will cut a flight cable segment, with minimum all fire pulse applied to bridgewire in both end detonators.							X	
2.10.7	ED Battery Performance Demonstration.							X	
	a. To verify battery activation.							X	
	b. To verify formation discharge of battery.							X	
	c. To verify battery operational capability after charging.							X	

*Performed 30 days or less prior to launch - off line.

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S	MATED	
					NON-FEAT	FEAT
2.10.8 Explosive Devices Circuit Resistance and Electrical Isolation.					X	
	a.	To verify the electrical integrity of all explosive device circuits and to obtain resistance data for comparative checks on circuit degradation (res. test can be done anywhere isol. only in pol. F).			X	
2.10.9 Explosive Devices Circuit Performance Demonstration.					X	X
	a.	To verify that the ED circuitry will fire initiator simulators upon command at altitude and at sea level).			X	X
2.10.10 Stray Voltage Check.					X	X
	a.	To verify no stray voltage is present in each firing circuit immediately prior to physical connection to the individual device.				
2.10.11 Demonstration of Proper Functional Operation of ED Circuitry After Each Appropriate Testing Sequence eg:						
	a.	Sys. A battery relay open.			X	X
	b.	Sys. B battery relay open.			X	X

TEST OBJECTIVES	PLANNED		BPA		KSC
	COLD FLOW		FINAL ASSEMBLY		
	A/S	D/S	A/S	D/S	MATED
					NON-FEAT
c. Simulator in place of initiators verified blown to demonstrate fixed initiator.				X	
2.10.12 Verification of Proper Circuit Isolation and Firing Circuit Resistances.				X	
2.10.13 Demonstration of ECI Operation.				X	
a. LM ECI are to be pneumatically operated and mechanically reset once to establish proper operations after potting and installation on the LM vehicle.				X	
2.10.14 To verify performance of special ED tooling a dummy booster cartridge installation will be performed to verify minimum clearances between ED explosive valves and plumbing and/or surrounding structure, circuit interrupter and surrounding structure, L. G. uplock and surrounding structure; Guillotine and surrounding structure, and interstage nuts and bolts and surrounding structure.				X	
2.10.15 Perform RFI/EMI Tests Using Low Energy Simulators for Pyro Initiators.				X	X

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC	
			A/S	D/S	A/S	D/S		
	BPA						NON-FEAT	FEAT
2.11 COMMUNICATIONS.								
2.11.1 ICS Tests.								
a. MIC & BIO-Med Voltage.							X	
b. CDR to LMP LMP to CDR levels.							X	
c. Master & ICS Volume Dynamic Range- CDR & LMP.							X	
d. Sidetone- CDR & LMP.							X	
e. VOX Sensitivity-CDR & LMP.							X	
f. ICS Qualitative Test.							X	
2.11.2 VHF Tests.								
a. Sensitivity-VHF A&B RCVRS CDR & LMP HDST.							X	
b. Squelch-VHF A&B RCVRS CDR & LMP HDST.							X	
c. AVC-VHF A&B RCVRS CDR & LMP HDST.							X	
d. Doppler-VHF A&B RCVRS.							X	

TEST OBJECTIVES	PLANNED		BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
e. Fidelity-VHF A&B RCVRS/CDR & LMP HDST.				X	X	
f. Transmitted S+N/N, VHF A&B XMTRS/ CDR & LMP MIC.				X	X	
g. Carrier Freq-VHF A&B XMTRS.				X	X	
h. Carrier Power-VHF A&B XMTRS.				X	X	
i. Noise Suppression OSC Effectiveness VHF A&B.				X	X	
j. Insertion loss & V.S.W.R. of R.F. cables.				X	X	
k. Down link power verification.				X	X	
l. PLSS Compatibility VHF voice and data high and low power.				X	X	
m. VHF/PLSS/suit compatibility.				X	X	
n. VHF low bit rate bit error count.				X	X	
o. LM/CM/PLSS compatibility voice and data.				X	X	
p. Tone ranging (qualification test).				X	X	

TEST OBJECTIVES	BPA				KSC	
	COLD FLOW		FINAL ASSEMBLY			
	A/S	D/S	A/S	D/S		
					MATED	
					NON-FEAT	
q. VHF voice qualitative test.				X	X	
r. VHF A-B volume control dynamic range.				X	X	
s. Functional performance of mission modes.			X	X	X	
2.11.3 S-Band Tests.						
a. Carrier Power-PRIM & SEC XMTR/PA.				X	X	
b. Carrier Freq-PRIM & SEC XMTR/PA (Incl. SPE).				X	X	
c. Threshold-PRIM & SEC RCVR (Incl. AGC Curves).				X	X	
d. Acquisition & Track-PRIM RCVR.				X	X	
e. Quieting Sensitivity-PRIM & SEC XCVR/ CDR & LMP HDST.				X	X	
f. S-Band Compatibility.				X	X	
g. Fidelity-PRIM & SEC RCVR/CDR & LMP HDST.				X	X	
h. Ranging Delay-PRIM XCVR/PA.				X	X	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
					X	X	
i. Margin Test- PRIM & SEC Power Amplifier.					X		X
j. S-Band Steerable Antenna Mechanical & Electrical Tracking.					X		X
k. Television transmission capabilities.					X		X
l. Functional Performance of Mission Modes.							
1. S-band downlink deviation test. (Lo & Hi power mode)					X		X
2. (ST-3) S-band low bit error rate.					X		X
3. (ST-10) S-band Hi bit error rate.					X		X
m. Insertion loss and VSWR of R. F. cables.					X		X
n. S-band voice qual test.					X		X
o. Verify EKG presence.					X		X
p. S-band volume control dynamic range (CDR and LMP)					X		X
q. S-band squelch dynamic range.					X		X
r. Functional check of steerable antenna heaters.					X		X

PLANNED TEST OBJECTIVES		COLD FLOW				FINAL ASSEMBLY				BPA		KSC
		A/E	D/S	A/S	R/S	MATED	NON-FEAT	FEAT				
s.	Mechanical slewing - S-Band steerable antenna.					X						X
2.11.4	D.U.A. TESTS.											
a.	D.U.A. Decoder test.						X					X
b.	D.U.A./LGC interface.						X					X
c.	D.U.A./S-band interface.						X					X
d.	Redundant S-band uplink voice.						X					X
e.	D.U.A. - TOKHZ back up voice test and level.						X					X
2.11.5	DSEA Tests.											
a.	Th correlation data input.											X
b.	1 KHZ tone input (Voice Annotative).											X
c.	Recorder tape display flag.											X
d.	Record command VOX voltage.											X
e.	Voice recording on tape.											X
f.	Time correlation data inputs on tape.											X

TEST OBJECTIVES	PLANNED		BPA		KSC
	COLD FLOW		FINAL ASSEMBLY		
	A/S	D/S	A/S	D/S	MATED
					NON-FEAT
					FEAT
g. Internal reference frequency on tape.				X	X
h. DSEA control via cabin communication panel switches.				X	X
i. Verify avoid-S/N ratio.					X
j. Verify harmonic distortion is within spec.					X
2.12 INSTRUMENTATION.					
2.12.1 Pulse Code Modulation & Timing Electronics Assembly (PCMTEA).					
a. Verify turn-on of the PCMTEA, related vehicle subsystem & GSE.				X	X
b. Verify mission elapsed time is resettable to zero and updates at one second intervals.				X	X
c. Verify PCMTEA provides timing signals.				X	X
d. Verify switchover of High/Low bit rate.				X	X
e. Verify analog 15% & 85% calibration voltage for High & Low bit rates.				X	X
f. Verify the Downlink ambient status check.				X	X

TEST OBJECTIVES	BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY	
	A/S	D/S	A/S	D/S
g. Verify 204.8KHZ oscillator failure is detectable.		X		X
h. Verify PCMTEA/ACE S/C synchronization.		X		X
i. Verify PCMTEA/LGC timing interface.			X	X
j. Verify ID format.		X		X
k. Verify indicator event timer and mission elapsed timer.			X	X
l. LM LBR-CSM - DJE interface.				X
m. Verify the redundant gate status check.				X
2.12.2 Signal Conditioning Electronics Assembly (SCEA).				X
a. Verify SCEA turn-on.				X
b. Simulate vehicle sensors and signal sources and verify:				X
			- Cabin display response only	
			- ACE S/C readout only	
			- Simultaneous cabin display and ACE S/C readout.	

TEST OBJECTIVES	PLANNED		COLD FLOW		FINAL ASSEMBLY		KSC
	A/S	D/S	A/S	D/S	MATED	NON-FEAT	
c. Simulate analog signals and verify: -DC analog channels -AC analog channels -Resistance temperature channels.					X		X
d. Verify discrete responses to relay and switch contact closures as well as to solid state equivalent switch closures.					X		X
e. Vehicle sensors provide inputs to the SCEA's.					X	X	X
f. The 15% and 85% High and Low bit rate calibration.					X		X
2.12.3 Caution & Warning Electronics Assembly (CWEA).							
a. Verify CWEA turn-on.					X	X	X
b. Simulate caution & warning inputs & verify: -Caution annunciator alarm functions. -Warning annunciator alarm functions. -Master alarm light functions. -Alarm indication reset functions. -Component caution alarm functions.					X		X
c. Verify discrete alarm parameters when alarm state inputs are applied.							X

TEST OBJECTIVES	BPA				KSC	
	COLD FLOW		FINAL ASSEMBLY			
A/S	D/S	A/S	D/S	MATED	NON-FEAT	FEAT
d. Verify analog alarm functions when alarm level inputs are supplied.				X		
e. Verify proper functioning of "multiple input alarms" to application of "Inhibits" and "Enables".					X	
f. Verify caution & warning inputs under ambient conditions.					X	
g. Jet logic checkout.					X	
2.13 CREW PROVISIONS.					X	
2.13.1 Waste Management Section (WMS), to Verify Structural Integrity and External Leakage.					X	
a. Leak check WMS using helium probe method.						
To Verify Internal Leakage of WMS.						
a. Leak check flow control valve internally using fluid displacement method.						
To Functionally Test the WMS.						
a. Functionally test the WMS at altitude using distilled water.						X

TEST OBJECTIVES	PLANNED		BPA		KSC
	COLD FLOW		FINAL ASSEMBLY		
	A/S	D/S	A/S	D/S	MATED
					NON-FEAT
					FEAT
b.	Purge WMS to dry.			X	
c.	Functionally test the WMS using distilled water.			X	
2.13.4	Fit and Functional Test.			X	
a.	Verification of accessibility and operational suitability of all stowed and crew station equipment as applicable as defined in the latest test crew provisions stores list.			X	X
b.	Top off PLSS O ₂ and H ₂ O.			X	X
c.	Verify COAS and docking target alignment using NAR test tool.			X	X
2.13.5	Servicing.			X	X
a.	Stow all provisions required for mission.			X	X
2.13.6	Crew Suiting Test.			X	X
a.	Verify liquid cooling garment and urine collection transfer acceptability.				

TEST OBJECTIVES	BPA		KSC	
	COLD FLOW		FINAL ASSEMBLY	
	A/S	D/S	A/S	D/S
				MATED
				NON-FEAT
				FEAT
b. Ingress of LM crew to vehicle.			X	X
c. Egress of LM crew from vehicle.			X	X

SECTION 3.0 - FEAT, SYSTEM VERIFICATION, PLUGS-IN TEST

FEAT, LM System Verification Plugs-In (OCP-GF-61015)

This test will be performed to verify quantitatively the performance of LM as a system in probable mission modes, under static and dynamic conditions. It is also performed to establish confidence in the system for a typical manned mission.

Major Mode I - Consists of vehicle power application and subsystem turn on and self test. This turn on mode consists of twelve major sub-sections and are as follows:

- a. Activation of ECS, EPS and Instrumentation. This essentially consists of application of water-glycol cooling, DC power via MAT connector to CDR and LMP buses, instrumentation SCEA, PCM high bit rate telemetry. Power switching from LUT connector, application of power from lower voltage of EPS status confirms EPS paths and configurations.
- b. The LM/CSM interface checkout comprises the activation of heaters for L.R., R.R., and the S-Band antenna; turn on of inertial platforms of primary and abort systems. This is followed by turn off of Instrumentation SCEA and PCM. Power switching of LM batteries and application of CSM power and back to LM batteries. The section concludes with a reactivation of Instrumentation SCEA and FCM via LM cabin controls and check of caution and warning lamps and displays.
- c. The test continues with an ECS checkout which checks the caution and warning of the water glycol primary loop, suit fan water separator and carbon dioxide sensor, and cabin repressurization valve. It continues with a checkout of the water glycol secondary loop; descent water tank, ascent water tank and oxygen tank controls and their associated displays and caution and warning.
- d. Next a caution and warning verification AC and DC bus low voltage conditions. The vehicle is then switched from GSE inverter simulator to inverter #1. This is followed by a lighting checkout of Flood, Docking, Numeric, Integral, and Tracking lights. Finally a check is run on the switching of the descent batteries low and high voltage taps.
- e. A communication voice link checkout is initiated with a turn on of the S-band primary transceiver and verification of S-Band up and downlink.
This is followed by VHF-A up and downlink verification. Finally the sequence is completed by a S-BD/VHF ranging test and bit error comparison plus DUA activation.
- f. Next a Propulsion Functional Checkout follows with a check of descent helium regulators, propulsion displays and controls, and propulsion caution and warning. This is followed by manual descent engine start/stop, ascent regulator and pressurization check, and manual ascent engine start/stop.
- g. An RCS functional checkout commences with a Helium Caution Reset and Propellant pressure and temperature checkout. The valve status is then checked along with the main SOV functions and the associated Caution and Warning. This is followed by a checkout of manifold pressure and verification of the heaters of both systems.

- h. Major Mode I continues with CES turn-on. This is as follows: FCS displays turn-on; ATCA and DECA turn-on; cabin controls set-up including T/TCA's. A verification is then made of the RGA run-up and CES with caution and warning. A reset Caution and Warning is followed by a set-up of the Start and Stop buttons, and circuits controlling the engines.
- i. The guidance systems are then activated and self checked. This is accomplished via LGC self test, G&N voltage and temperature checkout, AEA self test and DEDA displays check.
- j. A CES checkout is comprised of the verification of GDA Fail Logic, and deadband and mode control switching.
- k. The Landing Radar and Rendezvous Radar are then activated and self tested with their respectively internal capabilities.
- l. The final turn-on consists of the activation of the DUA and adjustment of its signal strength.

Major Mode II - Consists of employing an Automatic Descent profile as generated by the LGC which is comprised of automatic engine ON-OFF, gimbaling and throttling and LGC pulse commands to the RCS jets. During the "profile," various functions are tested such as DC voltage switching (Hi-Lo), radars commanded and radar data fed to the LGC and the communications. There are three individual tests which are enumerated below:

- 1. Test 1 consists of nominal AC and DC voltages which are utilized during the profile. The following are performed concurrently with the descent profile, rendezvous radar antenna slewing under manual control, landing radar antenna switching under manual control. Also included are the switching ON and OFF of docking lights.

Although the voltage remains at a nominal value, D.C. switchover is made from LO Voltage 26.5 to Hi Voltage 28.5 taps. In parallel to the above, the Ascent Batteries 32.5 are switched ON and OFF via Normal Feed.

A communications check is run on S-Band PM, via primary transceiver and amplifier, and OMNI Antenna 1, which contains commander voice and biomed data; and PCM data at high bit rate. A system engineer's communications switchover from VHF-A to S-Band and to VHF-B utilizing VHF Antenna 1. A BIT error comparison and S-Band ranging test is performed.

- 2. Test 2 consists of the profile operating again under degraded voltage conditions, specifically switching from low limit to high limit.

The profile again is exercised, but includes docking light operation as well as the DC power switchover from Descent Batteries to low Voltage Taps (26.5 VDC), to high Voltage Taps 28.5. In parallel to the above, the Ascent Battery 6 is switched ON and OFF, via normal and back-up feed, at 32.5 VDC. The following are also performed; Inverter 2 supplies A.C. bus, the Descent He Regulator valves are actuated and the PQGS probe is operated with stimuli of 1V, 5V and 0V. The radars are employed by positioning the Landing Radar via LGC and manual control and slewing the Rendezvous

Radar under manual control, and performing a R. R. self check. The communications are exercised by the transmission of data via S-Band PM tied to the primary transceiver and amplifier and Omni Antenna 2 and 1. This data consists of commander's voice, bio-med data and PCM at high bit rate. The S-Band steerable antenna is also slewed. Finally the LM Mission Pilot's communication is checked on VHF-A transmitter and receiver, in the simplex mode via VHF Antenna 2.

3. Test 3 consists again of operating the profile under degraded power conditions (switching from 26.5 VDC to 32.5 VDC) and the voltage and frequency of the AC bus are varied from low to high limits. Under these conditions, the following functions are verified: flood-light operation; switchover from Glycol Pump 1 to 2; and a communication check. This consists of transmitting S-Band PM, via primary transceiver and amplifier via OMNI #1. The data consists of commander's voice and biomed data with the PCM at the high bit rate. The LM Mission Pilot's voice communications is checked on VHF-A transmitter and receiver in the simplex mode, via VHF Antenna 1.

The descent profile in this test is modified with the following manual functions; manual throttle override via T/TCA, manual disable of gimbaling via gimbal enable switch, and D. E. start stop via cabin button.

Major Mode III - Consists of Abort and Abort Stage in the AGS mode with degraded power at ED logic buses.

Test 1 - At this point in the test, the vehicle is electrically demated. The remainder consists of PGNS Auto Ascent, AGS Auto Ascent, and Post Test Shutdown.

Major Mode IV - Consists of PGNS Auto Ascent. A profile consisting of Ascent Engine ON-OFF, and an RCS jet profile. This is accomplished via a load of the LGC. A low voltage condition of the DC buses is an initial condition and the Rendezvous Radar is slewed during the profile.

Major Mode V - Consists of a vehicle shutdown which removes power and cooling in the following order:

1. PGNS
2. AGS
3. Landing Radar
4. Rendezvous Radar
5. RCS
6. Propulsion
7. CES
8. Communications
9. ECS
10. EPS
11. Vehicle Power
12. Vehicle Cooling

SECTION 4.0 - FEAT, MISSION ORIENTED PLUGS-OUT TEST

Section 4.0 - FEAT, Mission-Oriented, Plugs Out Test OCP-GF-61018

This test will be performed to verify all functions which are planned for the Lunar Mission. The six phases are: (1) Pre-Separation Checkout (2) Separation, Powered Descent, Landing (3) Lunar Stay, and Lunar Pre-Launch Checkout (4) Ascent, Rendezvous, and Docking (5) Post-Docking Deactivation. These six phases comprise the sections of the test with the addition of (6) Abort - Abort Stage and Rendezvous Checkout.

Pre-Separation checkout commences with power applied via a CSM connection and then switched over to LM batteries. The cabin lighting is switched on and the following systems are activated and self checked; Instrumentation, Caution and Warning, ECS, Communications, Propulsion, RCS, Primary Guidance, Abort Guidance, Landing Radar and Rendezvous Radar. In addition, the PGNS is fine aligned and the AGS aligned to it, and the state vector is loaded into the LGC and transferred to AEA.

Separation, Powered Descent and Landing, commences with a simulated minus X translation initiated at the DSKY. Cabin switches are set for a short descent burn, an ullage maneuver is performed, and the descent engine is started via DSKY command. (This simulates orbit insertion). Verification is made that helium pressurization fuses are blown, EPS modes are set for powered descent, and the tracking light is turned on. The instrumentation monitoring RCS systems A and B and the ascent tanks are checked, the R.R. is self-checked, and the data is verified via the DSKY.

Cabin switches are then set for a second DPS burn and the LGC is loaded with the burn profile via the DUA. Suit fan #1 and glycol pump #1 are turned on and the second profile is initiated. The gimbaling, throttling and RCS commands are stored on the FR 1400 tapes. The suit fan and glycol pump are then turned off.

Manual functions associated with the landing maneuver are verified and the ACA and T/TCA and engine start and manual stop switches are exercised.

Lunar Stay commences with an EPS checkout (descent and ascent batteries and AC and DC busses), switching to flight inverters, and verifying voltage and frequency. A check is run on the RCS systems A and B temperature and pressure and ascent and descent water tank instrumentation.

The IMU is fine aligned and EPS modes selected for an Ascent burn by tying ascent and descent batteries in parallel. The ascent oxygen and water tanks are verified via caution and warning displays. Checkout of the AGS is performed via self-test. A check of the Rendezvous Radar is made by designating specific antenna positions. The cabin switches are then set for Ascent burn. Suit fan #2 and glycol pump #2 are then turned on the ascent engine armed.

Ascent, Rendezvous and Docking, commences with ascent helium pressurization. A profile is loaded into the LGC via the DUA. Suit fan #2 and glycol pump #2 are turned off and the Ascent Engine is switched off for coast. The Rendezvous Radar is self checked having the LGC strobe the self test data for range and range rate and display via the DSKY. The +X axis burn is then commanded via DSKY. A check on ascent fuel and oxidizer tank instrumentation is made and this is followed by an EPS status check of DC

and AC busses. Another +X axis burn is commanded, followed by docking light activation (all five lights). The AEA is operated to simulate attitude alignment. The T/TCA is operated to simulate translation for docking.

Post docking deactivation is performed by turning off docking lights.

The Abort - Abort Stage and Rendezvous is initiated by placing the cabin controls in auto descent configuration, resetting the event timer and installing ED simulators. Depress abort and abort stage buttons in turn and verify all ED simulators have fired. A manual control of the vehicle is then simulated with T/TCA in two and four jet selection, and maneuver with the ACA, (accomplished with AEA in orbit align).

SECTION 5.0 - RETEST PHILOSOPHY

Section 5.0 – Retest Philosophy

Because of possible retrofits, failures, troubleshooting, etc., a certain amount of previously accomplished testing may be invalidated and therefore must be reverified. Specific retest requirements shall be established for each situation, based upon the following general ground rules:

A. GENERAL

1. Re-verification may require delta testing or may utilize downstream testing but must be accomplished prior to the start of the FEAT/EMC System Verification, Plugs-In. However, if troubleshooting or a replacement is required during the FEAT, Plugs-In Test, the re-verification must be accomplished before the completion of the FEAT Plugs-In Test by re-running the appropriate test procedure sequences.
2. The documentation that identifies and authorizes the operation resulting in invalidation of previous testing must include the specific retest requirements for re-verification of the vehicle or test constraints, and must be approved by the Resident Assistant Manager, Apollo Spacecraft Program Office.

B. ELECTRICAL

1. All electronic replaceable assemblies must be pre-installation tested in accordance with existing specification and time limitations to verify that the assembly, by itself, meets the required performance criteria.
2. Any suspected or failed assembly removed from the spacecraft must be recycled through a pre-installation test, plus any bench level delta testing that may be required to isolate malfunctions. Units which have exhibited intermittent failures must not be reinstalled into the spacecraft until the cause of the failure has been determined and corrected.
3. If an electronic assembly is replaced in the spacecraft with a different unit, all functional modes and all functional paths to and through the replacement assembly must be re-verified.
4. When assemblies are removed from the spacecraft solely for access to other equipment, only an interface integrity test will be performed.
5. All electrical connectors which are demated or replaced must have all functional paths re-verified after remating.

C. FLUID AND MECHANICAL SYSTEMS

1. The replacement of components or the breaking of any fluid system will require, at a minimum, leak tests of the broken connections to normal operating pressures and re-verification of the re-worked area. Replaced relief valves will be pressure tested to MDOP. Functional verification in the spacecraft is required on replacement components.
2. Mechanical assemblies that have been functionally tested in the spacecraft and subsequently invalidated because of removal and/or replacement are to be re-verified for fit and function.

SECTION 6.0 - GENERAL REQUIREMENTS

Section 6.0 - General Requirements

1. Positive pressure is to be maintained on all tanks at all times for atmospheric pressure changes and for maintaining systems cleanliness.
2. The IMU temperature controller is to be activated and monitored at all times except when on internal power.
3. The Abort Sensor Assembly temperature controller is to be activated and monitored at all times except when on internal power.
4. G&N parameter verification tests are to be conducted on the PIPA scale factor and bias and on the IRIG scale factor and drift coefficient on a periodic basis normally not to exceed 60 days between tests.
5. Cabin air to be provided during all test operation in order to maintain cleanliness and provide cooling.
6. Provide cooling to electrical subsystems utilizing GSE circulated water glycol.
7. Prior to the introduction of any fluids into spacecraft systems, spec requirements of the fluids must be verified.
8. Abort and simulated mission sequences are to conform to the AOH as closely as possible within test configuration and facility constraints.
9. Crew participation is required in the following:
 - a) Crew compartment fit and functional.
 - b) Mission simulated, plugs-out.
10. An accounting of limited life or limited cycle items will be maintained.
11. LM configuration will be verified to compatible with each test and GSE prior to any test.
12. Flight Instrumentation used for spacecraft evaluation shall be verified/calibrated prior to use.
13. The current Apollo Operations Handbook (AOH) procedures will be utilized where applicable to the LM Manned Flight Vehicles to accomplish corresponding OCP sequences for OCP 61018 at Bethpage as well as all tests at KSC involving the flight crew. These OCP's shall deviate from the AOH procedures only when required to meet approved test objectives or test constraints.

SECTION 7.0 - SAFETY REQUIREMENTS

Section 7.0 - Safety Requirements

BPA operations are to be in accordance or conformance with the following considerations or conditions:

Identification of all hazardous operations.

The planning operations to minimize the exposure of personnel to hazardous conditions.

Verification that all inputs to the spacecraft systems are correct before connection or insertion is made.

All nonflight equipment introduced for testing must be nonhazardous.

All hardware and associated software must meet required configurations and must have received proper controlled handling.

Supporting personnel must have been trained in the respective operations for achieving satisfactory test data while maintaining the safety of the space vehicle, equipment, crew, and other support personnel.

A planned method for restoring the vehicle to a safe configuration following an interruption of the test.

A plan for the escape and rescue of the crew and supporting personnel during all hazardous tests.

Pretest verification of the test readiness of all facilities employed in checkout operations.

The protection of the spacecraft and its systems from exposure to harmful environments or contaminants.

The providing of maximum protection against damage to the spacecraft or space vehicle as a result of accidental fluid leakage or spillage.

Operational checkout procedures and safety program documents must be evaluated and reviewed to assure that they:

Will not create destructive damage to any spacecraft system or to the crew.

Are applicable for the hardware configuration.

Contain the proper safety requirements, warning, and caution notes to insure maximum personnel identification of and awareness of all hazards involved.

Have back-out (emergency) capability.

Do not initiate unscheduled or out-of-sequence events.

SECTION 8.0 - SUBSYSTEM SUPPORT MATRIX

System Under Test

		ELECTRICAL POWER SUBSYSTEM	LIGHTING SUBSYSTEM	INERTIAL MEASUREMENT SYSTEM	LM GUIDANCE COMPUTER	ALIGNMENT COMPUTER UNIT	LANDING OPTICAL RADER	RENDEZVOUS
Electrical Power Subsystem		X						
Lighting Subsystem		X						
Inertial Measurement Unit		X X		X				
LM Guidance Computer		X X	X					
Alignment Optical Tracker		X X						
Landing Radar		X X						
Rendezvous Radar			X					
Abort Electronics Assembly		X X	X X	X X	X X	X X	X X	
Abort Sensor Assembly		X X	X X	X X	X X	X X	X X	
Control Electronics Section		X	X X	X X				
Reaction Control Subsystem		X	X X					
D/S Propulsion Section		X						
A/S Propulsion Section		X						
Explosive Devices Subsystem		X						
ICS Communication		X X						
VHF Communication		X X						
S-Band Communication		X X						
DUA Communication		X X						
DSEA Communication		X						
PCMTEA Instrumentation		X						
SCEA Instrumentation		X						
CWEA Instrumentation		X X						
Heat Transport Section								
Environmental Control Subsystem								
Displays Section		X X						

FOLDOUT FRAME

A

SYSTEM IN SUPPORT

8-1